SCHOFIELD BARRACKS MILITARY RESERVATION, **HAER No. HI-81**
KU TREE RESERVOIR
Kalakoa Stream
East Range
Wahiawa Vicinity
Honolulu County
Hawaii

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Department of the Interior
1849 C Street, NW
Washington, D.C.

HISTORIC AMERICAN ENGINEERING RECORD

SCHOFIELD BARRACKS MILITARY RESERVATION, KU TREE RESERVOIR

HAER No. HI-81

Location:	Kalakoa Stream (Tributary to the South Fork of Kaukonahua Stream) East Range, Schofield Barracks Military Reservation Wahiawa Vicinity City and County of Honolulu Hawaii USGS 7.5 minute series topographic map, Waipahu, HI 1998 Universal Transverse Mercator (UTM) coordinates: 1. 04.606000.2377830 3. 04.605440.2377300 2. 04.606000.2377300 4. 04.605440.2377830
Date of Construction:	1922-1925
Engineers & Builders:	Office of the Quartermaster General and Office of Chief of the Fourth Construction District
Present Owner:	U.S. Army
Present Occupant:	U.S. Army (training area)
Present Use:	Reservoir drained and abandoned.
Significance:	The Ku Tree Reservoir is associated with the history of water infrastructure development on Oahu. Also, from its opening in 1925 until 1938 it served as the primary source of water for Schofield Barracks Military Reservation. Thus, the reservoir is historically significant for its associations with the development and expansion of this Army post.
Report Prepared by:	Don J. Hibbard, Ph.D., Architectural Historian as subcontractor to and with assistance from Mason Architects, Inc. 119 Merchant Street, Suite 501 Honolulu, HI 96813
Date:	June 2008

GENERAL DESCRIPTION AND LOCATION

The Ku Tree Reservoir is a complex with a number of man-made components: hydraulic earth-fill dam, valve tower, valve tower foot bridge, drain tunnel, discharge tunnel, portal number 6, spillway, and spillway foot bridge. The dam, valve tower, valve tower bridge, and spillway are individually addressed in the following reports (HAER No. HI-81-A, 81-B, 81-C, and 81-D). The drain and discharge tunnels and portal number 6 are covered in the report on the valve tower (HAER No. HI-81-B), and the spillway bridge is discussed in the spillway report (HAER No. HI-81-D). Other structures associated with the water supply for Schofield Barracks Military Reservation (the Canon and Koolau Reservoirs, the intake tunnel, and the concrete tunnels, ditches, and siphons which transported water from Canon Reservoir to Ku Tree Reservoir) will not be affected by the breaching of the Ku Tree Reservoir, and therefore are not being documented.

Ku Tree Reservoir is located in Tax Map Key (TMK) parcel 7-6-001: 001. This is within the East Range of Schofield Barracks Military Reservation along the eastern extremity of the Schofield Plateau. No longer functioning as a reservoir, its earth-filled dam and other structures are approximately three miles east of the town of Wahiawa, at a point on the Kalakoa Stream approximately two miles above its confluence with the South Fork of Kaukonahua Stream. The approximate USGS coordinates of the dam are: 21 degrees, 30 minutes North latitude and 150 degrees, 59 minutes West longitude. The nearest public roadway is Kamehameha Highway (State Highway 99), which is three miles to the west of the reservoir. Access to the reservoir is via Higgins Road (also known as East Range Road), a military road which is paved up to a locked gate and then becomes an unpaved dirt road. Except for the dam, appurtenant structures, and access roads, no permanent man-made structures exist in close proximity to the reservoir site.

HISTORICAL CONTEXT

Early Development of Schofield Barracks

On August 12, 1898, Hawaii was formally annexed as a territory of the United States. Over the next six years the military analyzed and discussed the strategic role of the islands in the defense of America. Finally in 1905, in an address to Congress, President Theodore Roosevelt declared Hawaii to be, “the most important point in the Pacific to fortify in order to conserve the interests of this country” (Meeken, 1974: 3).

The logic behind this decision was based on the fact that the effective range of a naval fleet at that time was approximately 1,500 miles. Thus any planned invasion of the United States from across the Pacific would require Hawaii as a stepping stone. By controlling Hawaii, the United States safeguarded its west coast.

The naval fleet based at Pearl Harbor was conceived as the islands' first line of defense. To protect the harbor, a series of coastal defense forts were proposed, and to protect these coastal artillery units from a rear land attack, a mobile infantry, cavalry, and field artillery force was to be stationed on Oahu. As early as 1902 the Kahauiki Tract, the present site of Fort Shafter, and 14,400 acres at Waianae-Uka, the present site of Schofield Barracks, were considered as potential locations to establish the Army's command post on Oahu. The major argument in favor of the former Crown lands at Waianae-Uka was its strategic location, situated on a plateau between the island's two major mountain ranges, offering central access to the North Shore of Oahu as well as to Pearl Harbor Naval Base and Honolulu to the south. However, the Waianae-Uka area was initially passed over because it had no readily available water source, and Fort Shafter was developed as the primary installation for the U.S. Army in Hawaii (Alvarez, 1982: 50; and Addleman, 1939: 3).

Following the establishment of Fort Shafter, construction commenced on Schofield Barracks in late 1908. These lands had been obtained by the United States government when Hawaii was annexed as a territory, and in turn were transferred to the War Department for military use in 1899 through Executive Order Number G.O. 147. On December 4, 1908, Captain Joseph C. Castner, construction quartermaster, arrived on Oahu to begin building a temporary cantonment on the Waianae-Uka military reservation. Captain Castner, with the help of local laborers, constructed tents for the officers and men, followed by temporary wooden barracks. The cantonment was informally known as Castner Village among military personnel. People in Honolulu referred to it as the Leilehua Barracks after the Leilehua Plain on which it was located. On January 13, 1909 the Fifth Cavalry Regiment, 473 men strong, occupied the new installation. At this time the post included 248 temporary buildings and a sewer and water system. In 1910 the Fifth Cavalry was joined by the First Field Artillery Regiment, and the following year the Second Infantry Regiment was also assigned to Schofield Barracks.

In 1913 construction commenced on permanent buildings for the post, and the 25th Infantry Regiment augmented the troop level so that by 1914 6,000 men were stationed at Schofield Barracks, with the 1st Field Artillery, 1st Infantry Regiment, 25th Infantry Regiment, and 4th Cavalry all garrisoned there. World War I saw the post's troop level reduced to nearly nothing, but in the years between 1920-1940 the post greatly expanded in size and population. By 1927, a cavalry post initially composed of tents had developed into a thriving military complex, and by the early 1930s, Schofield had become the United States Army's largest installation; in 1938 over 14,000 troops were stationed there (Addleman, 1939: 6 & 43-44; *Infantry Journal*, 1927: 447-455; and *Honolulu Star Bulletin*, February 1, 1933: p. 6 and June 27, 1933: sec. 3, p. 2).

Schofield Barracks' Water Supply

Throughout the first twenty-nine years of Schofield Barracks' history, the infrastructure issues related to water remained critical problems. When building the post, Captain

Castner's laborers were quartered in Wahiawa for lack of water at Leilehua. In February 1909, Congress passed an act which granted Wahiawa Water Company a right of way through Schofield Barracks to construct reservoirs, canals, and their laterals upon the proviso that the company, "shall furnish free of charge all the water needed for post or encampment purposes" (U.S. Army, Office of the Judge Advocate General, 1916: 105). Until those improvements were built troops had to transport water from Fort Shafter to Schofield, and as late as December 22, 1912 the *Pacific Commercial Advertiser* (p. 5) reported that the "water question at Schofield Barracks is still unsolved and the lack of water there may prevent the stationing of further bodies of troops until the new reservoir and piping system are installed." In 1912 horses were still taken down to the Wahiawa reservoir for water.

Both the Koolau and Waianae mountains were exploited as sources of water for the new installation. The Army's real estate records, held by the Directorate of Public Works, and the drawings for Ku Tree Reservoir give some indications of the early history of water supply for Schofield Barracks. In early years water was pumped from three shallow tunnels in the Waianae mountains. In late 1913, Lord-Young Engineers were awarded a contract to construct a new reservoir system on the Koolau mountain-side of the Army post to supply the burgeoning military reservation. Over the next five years the Canon and Koolau Reservoirs were constructed, with Canon completed in April 1919, and Koolau in the following month. Canon Reservoir featured a 20-foot-high, 50-foot-long, stone intake dam on Kaukonahua Stream. The reservoir held 7,011,000 gallons, with tunnels and flumes transporting its waters to the Koolau Reservoir. The Koolau Reservoir had a capacity of 45,000,000 gallons, and its 70-foot-high, 270-foot-long earth-filled dam was reinforced by concrete retaining walls. A pipeline delivered water from the reservoir to Schofield Barracks (*Honolulu Advertiser*, December 23, 1952: 4).

Despite the construction of this reservoir system, water shortages continued to affect military activities at Schofield, and on March 12, 1921 a Post Water Conservation Officer was appointed to enforce restrictions on the use of water as rainfall had been light and the post's total storage capacity provided only for thirty days of consumption. To meet the barracks' increasing demand for water the Ku Tree Reservoir was constructed. In addition, tunnels and siphons were constructed to allow the new reservoir to directly access the Canon Reservoir's water supply.

Development of Ku Tree Reservoir

Described by the *Honolulu Advertiser* (September 14, 1924: 7) as, "one of the most important building projects in the history of the Hawaiian department of the army," the Ku Tree Reservoir was completed in 1925. Its dam is approximately 550' in length and 90' high, with a crest width of about 30'. With a capacity of almost 300 million gallons, Ku Tree Reservoir connected into the pipeline of the existing Koolau Reservoir, providing Schofield Barracks with total water storage of 340 million gallons.

Planning for the reservoir began in 1919 when two representatives of the construction service, attached to the Quartermaster General in Washington D.C., visited Hawaii to make a site inspection. They returned to the nation's capital and drew the plans for the new structure with the aid of members of the construction service stationed in the islands *(Honolulu Advertiser,* September 14, 1924: 7). [The names of the engineers or designers are not known, but the initials, under "Drawn by", on the 1919 drawings are W.W.B., while those on most of the 1923 and 1924 drawings are G.N. All the drawings are shown in the title block as being issued in Honolulu, with four of the sheets from the Office of the Constructing Quartermaster, but the majority from the Office of the Chief of the Fourth Construction District.] In designing the reservoir, the dam was advantageously sited at a narrow opening in the gulch, with four site alternatives considered. In 1921 Congress appropriated the necessary funds to construct the reservoir. The reservoir was planned and built by the construction service of the Quartermaster Corps, which had the responsibility for all army construction projects with the exception of coastal defense systems, which fell under the domain of the Army Corps of Engineers. Because of the distance between Hawaii and Washington, D.C., the chief of the Fourth Construction District in Honolulu was responsible for overseeing the Ku Tree Reservoir project.

Construction of the reservoir commenced in October 1922, and by August 1924 the reinforced concrete foundation for the dam had been laid, the redwood core wall was in place, and 105,000 of the 175,000 cubic yards of earth had been placed on the embankment walls. Historic photos show that a combination of man-, animal-, and machine-power was used in the construction efforts. The dirt for the dam was set in place hydraulically. In order to transport the dirt to the site, a 200-gallon-per-minute pumping plant was constructed. Water, obtained from the stream through a diversion tunnel, was pumped to the top of a hill north of the dam. The hill was comprised of a red-and-yellow-colored volcanic soil of a clayey nature. The soil was first loosened by dynamite and black powder, and then carried off to the dam site by the pumped water. The water carried the large and fine particles of soil via a flume to the dam site where appropriately placed lateral flumes deposited the mixture to make the embankments. In the early stage of the project, it was discovered the soil was of such a consistency that the rim would not hold itself. As a result a wire mesh was used to retain the large particles until they were sufficiently hard to hold themselves. The metal screens were then removed and lifted to a higher level (*Honolulu Advertiser*, February 21, 1925: 1).

The construction of the reinforced-concrete elements of the reservoir (valve tower, which was over one hundred feet high, cutoff wall, and spillway) presented another problem, as all the materials for their construction had to be brought in to this wilderness location and prepared on site. The reservoir was completed on February 21, 1925. The total cost of the reservoir was $498,079.78 (Directorate of Public Works, and *Honolulu Advertiser*, February 21, 1925: 1).

Abandonment

Although the Ku Tree Reservoir greatly increased Schofield Barracks' water supply, the military reservation continued to face threats of water shortage. In times of drought, the reservoir dried up. In May 1926, the water supply fell below what was deemed safe for fire protection, forcing the Army to move almost all the troops from Schofield Barracks to other camps. A month later, following a period of heavy rains, the troops moved back. Because of the water situation, off-base summer maneuvers were often scheduled. Restrictions on water use were again put in effect in February 1934, because of a dwindling supply. In addition to Ku Tree Reservoir's inability to serve as a stable and sufficient source of water, its quality was often in doubt and the water was heavily chlorinated.

In order to solve the need for additional water, Harold T. Stearns, a geologist with the U.S. Geological Survey, in September 1933 suggested to Major General B. H. Wells that the Army consider drilling an artesian well equipped with an air-lift pump. After three years of discussions and investigations, in 1936 the Army Corps of Engineers commenced work on a 1,700-foot-long inclined shaft, located outside the gate at Wheeler Air Field, in order to develop artesian wells to provide Schofield Barracks with water. At the end of the shaft, pump rooms were carved out of the rock (Stearns, 1936). In 1938 the underground engine room, electric pumps, and piping needed to bring water to Schofield Barracks was completed and the new water source inaugurated (U.S. Army Museum of Hawaii, n.d.). Schofield still relies on this artesian well today.

After the Ku Tree Reservoir was abandoned as a source of domestic water, it continued to be used for irrigation purposes, with its waters, as well as those in Canon and Koolau Reservoirs, held in reserve. The reservoir was kept operational into the 1970s, when the Army considered using it for recreational fishing. There was a record of draining the reservoir in 1975 to repair service tunnels or gates (C-E Maguire, Inc. 1978: 26-27). Soon thereafter, events on the mainland affected the decisions about the continued use and repair of this and other dams.

Following the disastrous failure in 1976 of the Teton Dam in Idaho, which resulted in eleven persons losing their lives and over $400 million in property damage, President Carter issued an April 23, 1977 directive requiring all federal agencies with dam construction responsibilities to review their dam building practices. This directive and subsequent laws modified the design, construction, and operation of federally controlled dams. In 1978 the Ku Tree dam was determined to be unsafe following an inspection under the National Dam Safety Program. The Army recognized they had to take measures to appropriately manage Ku Tree Dam to prevent dam failure and possible environmental impacts associated with such an event. In 1983 they secured the services of Walter Lum Associates, Inc. to inspect and make a structural evaluation of concrete, reinforced concrete, and metal appurtenant structures associated with the reservoir and make repair recommendations to extend the life of the facility for at least twenty-five years. The water in the reservoir was completely drawn down and emptied in order to facilitate the study of the structures, and the reservoir has remained empty since that time.

SOURCES

Original 1920s drawings for Ku Tree Reservoir, Job No. S3603, are digitally archived at the Directorate of Public Works, U.S. Army Garrison, Hawaii. There is also one 1943 drawing of the water system, showing the Canon, Koolau, and Ku Tree Reservoirs.

Doc. Number	Title & Sheet #	Date	Office in Title Block	Drawn by	Traced by
S3603001	Ku Tree and Koolau Reservoirs Sites with Connecting Tunnels... Sheet 1	July 1923	Constructing Quartermaster	G.H.E.	G.H.E.
S3603002	Contour Map [upstream portion] Sheet 2	May 1919	Constructing Quartermaster	W.W.B.	S.S.
S3603003	Contour Map [showing dam area] Sheet 3 Alt dam sites	May 1919	Constructing Quartermaster	W.W.B.	S.S.
S3603004	Plan of Dam Sheet 4	June 1924	Chief of the Fourth Construction District	G.N.	G.N.
S3603005	Concrete Cutoff Wall & R.W. Core Wall Sheet 5	Oct. 1924	Chief of the Fourth Construction District	G.N.	G.N.
S3603006	General Plan, Spillway Sheet 6	Nov. 1924	Chief of the Fourth Construction District	G.N.	G.N.
S3603008	Lower Half of Spillway Sheet 8	Nov. 1924	Chief of the Fourth Construction District	G.N.	G.N.
S3603011	Valve Tower Elevation and Section Sheet 11	Sept. 1924	Chief of the Fourth Construction District	G.N.	L.T.
S3603013	Valve Tower Details [Elev. 999'] Sheet 13	June 1924	Chief of the Fourth Construction District	G.N.	F.L.
S3603014	Valve Tower Details [Elev. 996'] Sheet 14	June 1924	Chief of the Fourth Construction District	G.N.	L.T.
S3603015	Valve Tower Details [Elev. 1030'] Sheet 15	Oct. 1924	Chief of the Fourth Construction District	G.N.	F.L.
S3603016	Valve Tower Details [Elev. 1030' to Top] Sheet 16	July 1924	Chief of the Fourth Construction District	G.N.	G.N.
S3603017	Valve Tower Operating Floor Detail Sheet 17	Oct. 1924	Chief of the Fourth Construction District	G.N.	L.T.
S3603018	Valve Tower - Details Sheet 18	Oct. 1924	Chief of the Fourth Construction District	G.N.	F.L.
S3603019	Valve Tower Details Sheet 19	Mar. 1923	Chief of the Fourth Construction District	B.H.	B.H.

S3603020	Valve Tower Details of Grizzly Sheet 20	Nov. 1924	Chief of the Fourth Construction District	G.N.	G.N.
S3603021	Valve Tower Gauge Sheet 21	June 1924	Chief of the Fourth Construction District	G.N.	L.T.
S3603022	Valve Tower Platforms & Ladder Sheet 22	Sept. 1924	Chief of the Fourth Construction District	G.N.	L.T.
S3603023	Valve Tower, Reinf. Steel Details Sheet 23	July 1924	Chief of the Fourth Construction District	G.N.	G.N.
S3603024	Valve Tower Reinf, Steel Schedule Sheet 24	Oct. 1924	Chief of the Fourth Construction District	G.N.	L.T.
S3603025	Valve Tower Steel Bending Diagram Sheet 25	Oct. 1924	Chief of the Fourth Construction District	G.N.	L.T.
S3603026	[Valve Tower] Thimbles for Sluice Gates Sheet 26	Mar. 1923	Constructing Quartermaster	Harrison	
S3603027	Valve Tower C.I. Thimbles and Screens, Inlet Gate Sheet 27	Nov. 1923	Constructing Quartermaster	G.N.	G.N.
S3603028	Valve Tower Gates Sheet 28	Dec. 1923	Constructing Quartermaster	G.N.	G.N.
S3603029	Suspension Bridge to Valve Tower Sheet 29	June 1924	Chief of the Fourth Construction District	W.F.J.	W.F.J.
S3603030	Suspension Bridge, Approach Sheet 30	July 1924	Chief of the Fourth Construction District	W.F.J.	W.F.J.
S3603031	Suspension Bridge, Details Sheet 31	June 1924	Chief of the Fourth Construction District	W.F.J.	W.F.J.
S3603032	Suspension Bridge, Steel Details Sheet 32	Oct. 1924	Chief of the Fourth Construction District	G.N.	G.N.
S3603033	Ku Tree Conduits, Sheet 33	Feb. 1923	Constructing Quartermaster	Johnson	Johnson
F132073001	Expansion of Ku Tree – Koolau Water System	Dec. 1943	U.S. Engineer Office	(Designed) A.C.W.	(Drawn) G.A.R.

Note: Sheets 7, 9, 10, and 12 are not included in the digitized database of plans and drawings for this Job at the Directorate of Public Works.

Addleman, William C. *History of the United States Army in Hawaii, 1849-1939*. Schofield Barracks: Hawaiian Division, 1939.

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Christian, Errol J. "Officials Dampen Fears About Unsafe Reservoir," *Ka Nupepa.* November 21, 1995, p. 2.

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_____. "Ku Tree Dam is Formally Opened by Army Chief," *Honolulu Advertiser*, February 21, 1925, p. 1.

_____. "History from Our Files," *Honolulu Advertiser*, December 23, 1952, p. 4.

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_____, "Schofield Barracks History," *Honolulu Star Bulletin*, June 27, 1933, sec. 3, p 2.

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Jackson, Donald C. *Great American Bridges and Dams*. Washington D.C.: Preservation Press, 1988.

Kimura International, Inc. *Breach Ku Tree Dam, Draft Environmental Assessment.* Prepared for U.S. Army Corps of Engineers, Honolulu District, April 2005.

McMahon, Nancy. Letter from Archaeology and Historic Preservation Manager of State Department of Land and Natural Resources (State Historic Preservation Division) to Colonel Floyd Quintana, Director of Public Works, U.S. Army, dated May 22, 2008.

Meeken, Colonel S.R. *The History of Fort Shafter, 1898-1974*, typescript in the Fort Shafter library, 1974.

Office of the Chief of the Fourth Construction District, Honolulu. 1920s drawings for Ku Tree Reservoir, Job S3603, digitally archived at the Directorate of Public Works, U.S. Army Garrison, Hawaii.

Stearns, Harold T. *Report on a Proposed Well Shaft and Tunnel for the U. S. Army at Schofield Barracks, Oahu*. Spreckelsville, Maui: United States Geological Survey, 1936.

Pacific Commercial Advertiser. "Troop Movements Cause of Worry," *Pacific Commercial Advertiser*, December 22, 1912, p. 5.

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_____. *Hydrologic and Hydraulic Analysis for Breaching Ku Tree Reservoir Dam*, Hawaii. Prepared for Directorate of Facilities Engineering, United States Army Support Command, Hawaii, August 1984.

U.S. Army Museum of Hawaii. Newspaper clipping about Schofield Barracks water supply, without title or author, no date.

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U.S. Department of Reclamation. *Design of Small Dams*, Washington D.C.: U.S. Printing Office, 1977.

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PROJECT INFORMATION

The following documentation was prepared under a larger contract for an Environmental Assessment (EA) to Breach Ku Tree Dam. The purpose of this documentation was to historically record the architectural elements of Ku Tree Reservoir. The Ku Tree Reservoir / Dam is located within the East Range of Schofield Barracks, along the Kalakoa Stream which feeds into the South Fork of the Kaukonahua Stream. The U.S. Army proposes to breach the dam by excavating a 400-foot-long channel through the natural hillside on the southeast side of the dam, in the area where the spillway is now located. The new channel will be concrete lined and have a bottom width of approximately 30 feet. The proposed channel will be tied to the existing discharge end of the spillway and stilling basin. Excavated material will be placed along the upstream face of the existing dam. It is proposed that the existing valve tower will be demolished and buried beneath the waste fill. The existing drain tunnel under the dam will be permanently plugged. The Army and the Hawaii State Historic Preservation Division (SHPD) have agreed that the reservoir structures are eligible for the National Register. The SHPD noted that "due to their dilapidated condition, they have lost their historic integrity. Therefore, we believe that the determination for the architecture concerns of the proposed project is 'no adverse effect' " (McMahon 2008). The Army agreed to the SHPD's request for documentation meeting Historic American Engineering Record (HAER) standards.

The project manager for the HAER documentation was Ann Yoklavich of Mason Architects, Inc. Don J. Hibbard, Ph.D. was the researcher and author of the reports, prepared as a subcontractor to Mason Architects. Both are architectural historians who meet the Secretary of the Interior's Professional Qualifications in architectural history. Carol Stimson of Mason Architects assisted with the editing and production of the reports. The large-format photographs were taken by David Franzen of Franzen Photography. Clearing of vegetation for the photography was done by the crew of Glad's Landscaping & Tree Trimming. Administrative coordination and the location map were provided by Wil Chee - Planning, Inc.

Figure 1: Location map.

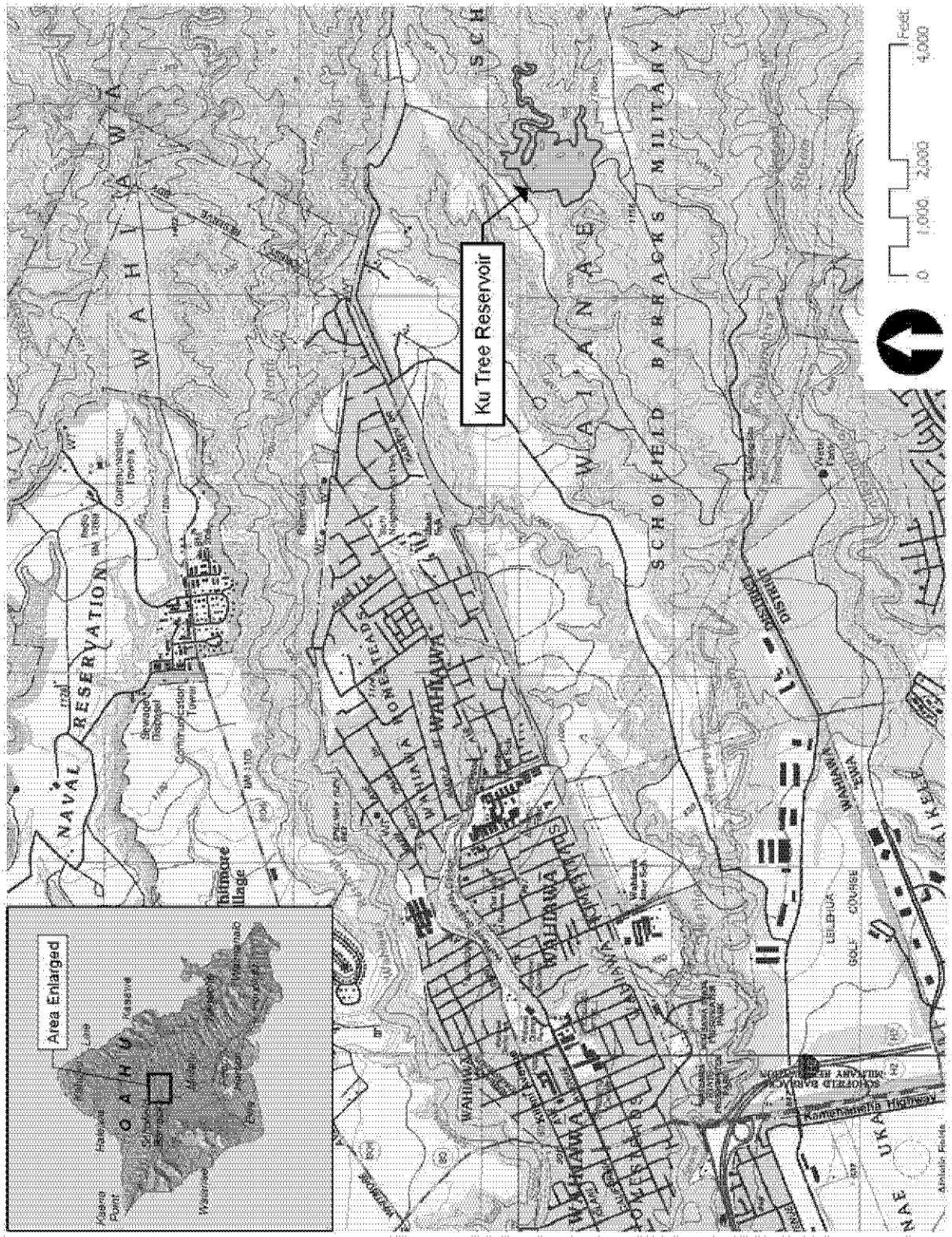

Figure 2: Plan of Dam, Ku Tree Reservoir. Job No. S3603, Sheet 4, dated July 1924.

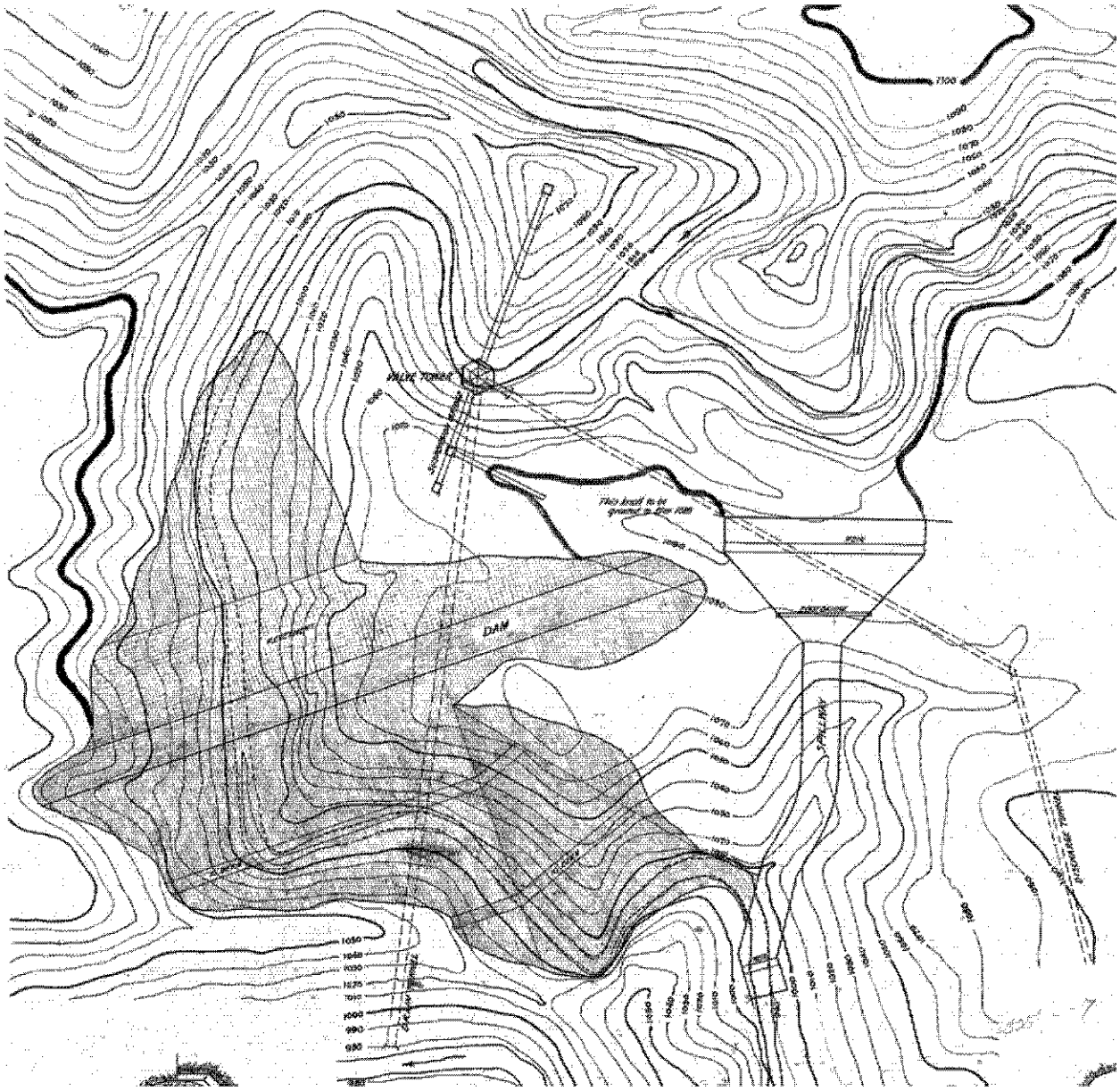

Figure 3: Schofield Barracks Water Supply, Ku Tree Reservoir Site with Connecting Tunnels & Pipelines. Job No. S3603, Sheet 1, dated July 15, 1929.

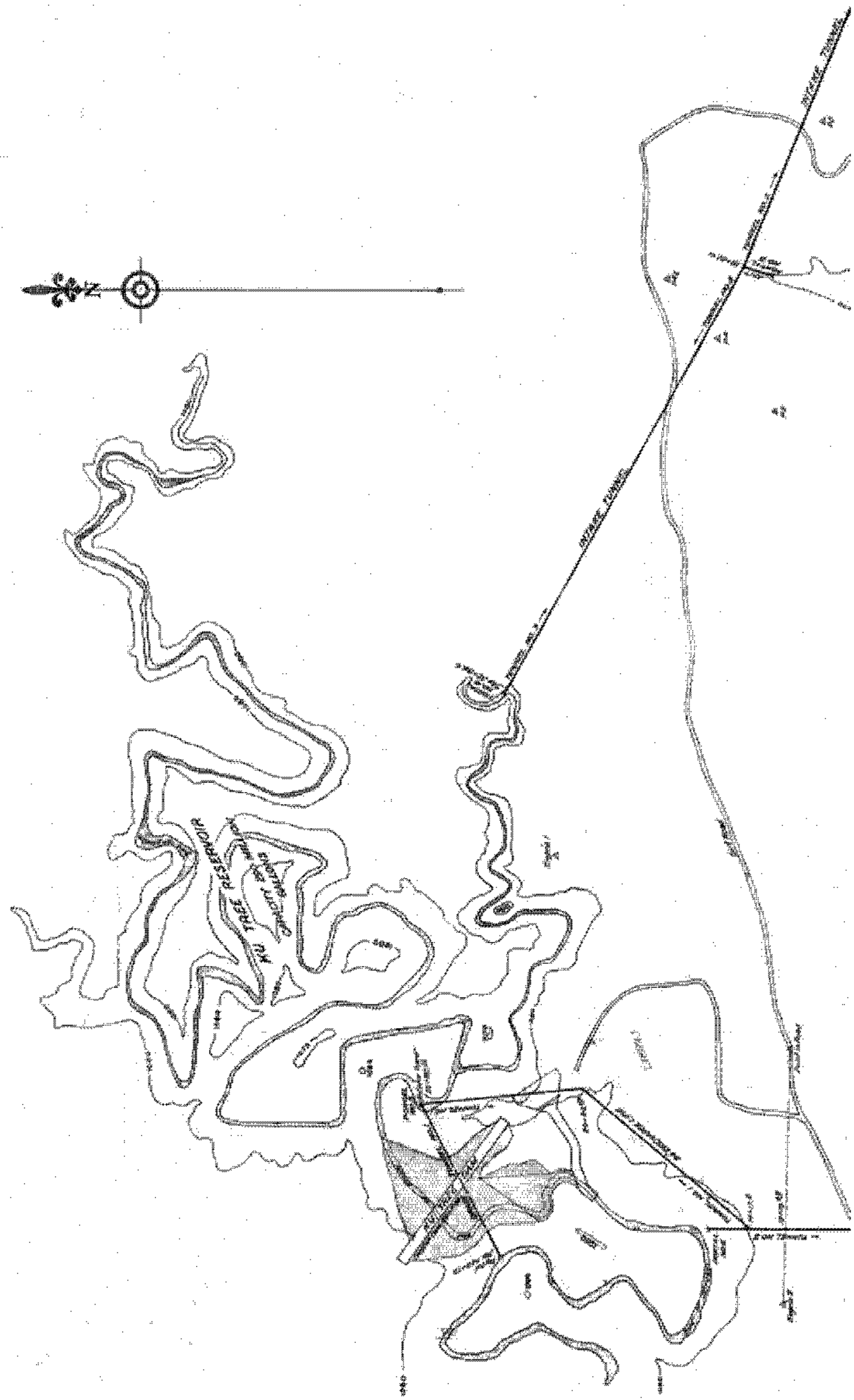

Figure 4: Ku Tree Dam (upper center) and Koolau Reservoir (lower center) on July 25, 1938. (National Archives II, Still Photo Section, photo order # 18-AA-51-37)

Figure 5: Starting point, Ku Tree Dam. (Tropic Lightning Museum, Schofield Barracks, Hawaii, Historical photograph 87.76.01-06)

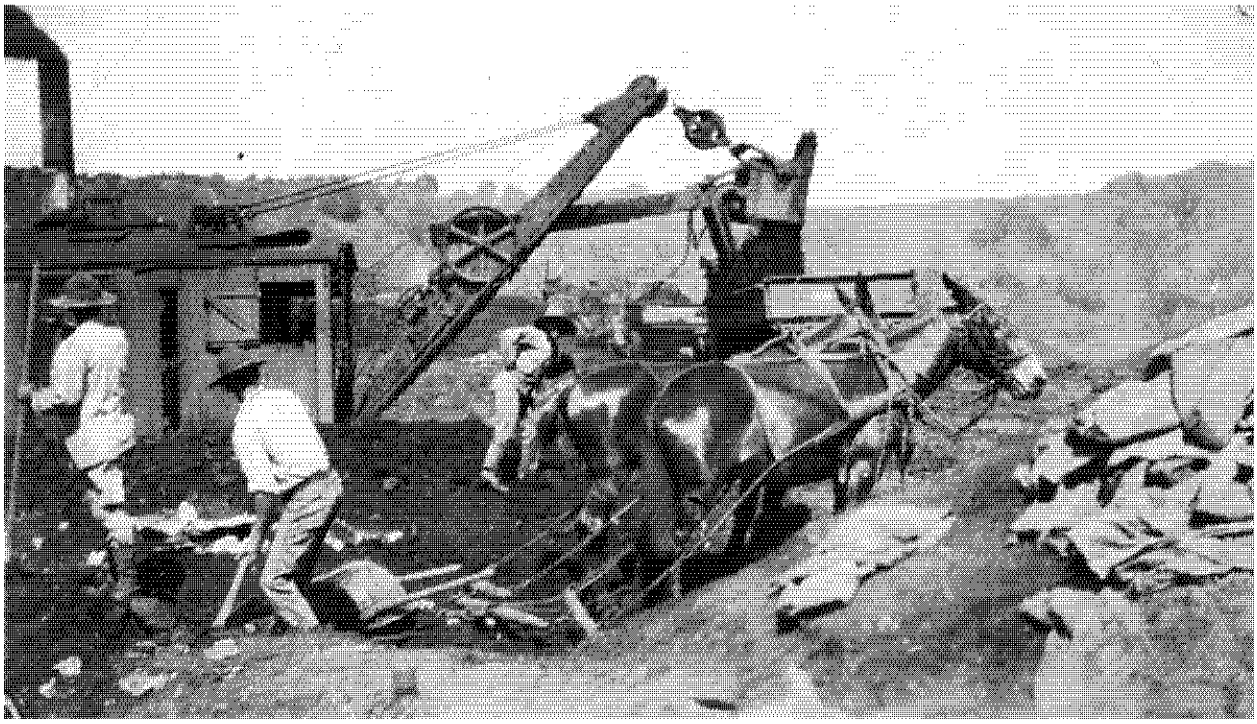

Figure 6: Ku Tree Dam, c. 1923-25, under construction. (Tropic Lightning Museum, Schofield Barracks, Hawaii, Historical photograph 87.76.01-03)

Figure 7: Workers' camp, Ku Tree Dam, 1925. (Tropic Lightning Museum, Schofield Barracks, Hawaii, Historical photograph 87.76.01-21)

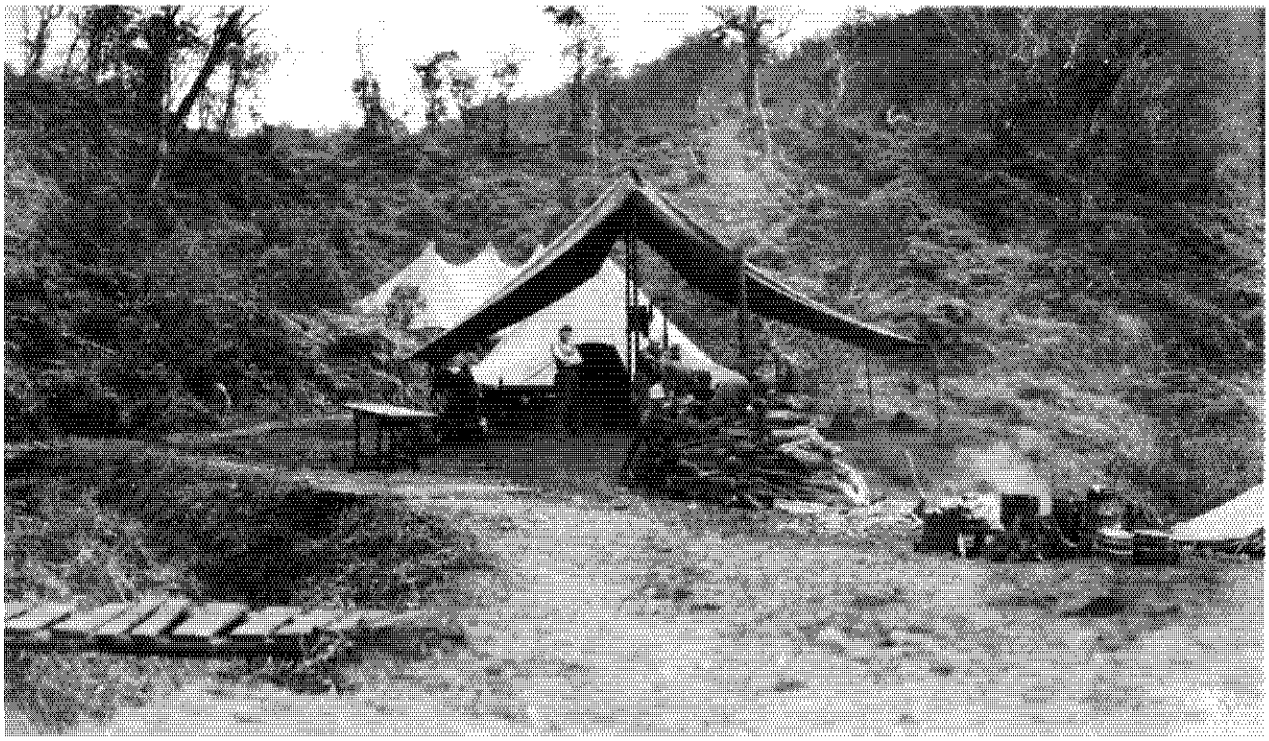

Figure 8: Dam with footbridge and valve house on tower in background. (U. S. Army Museum, Fort DeRussy, Hawaii, Historical photograph USAMH 6349)